3. CONCLUSIONS

3.1 Findings

1. The flightcrew was properly certificated and operationally qualified for the flight in accordance with company procedures and the Federal regulations.

2. The airplane was properly certificated and maintained, and there was no evidence of preexisting airplane structural, flight control systems, or engine faults that contributed to the accident.

3. In view of all the circumstances, the captain's decision to land on runway 10 was inappropriate.

4. The flightcrew members had experienced a disruption of circadian rhythms and sleep loss, which resulted in fatigue that had adversely affected their performance during a critical phase of flight.

5. The flightcrew had been on duty about 18 hours and had flown approximately 9 hours at the time of the accident. The company had intended for the crew to ferry the airplane back to Atlanta after the airplane was offloaded in Guantanamo Bay. This would have resulted in a total duty time of about 24 hours and 12 hours of flight time, the maximum permitted under 14 CFR Section 121.521, supplemental rules for overseas and international flights.

6. If the flightcrew had been scheduled to conduct a flight within the United States, similar to that of flight 808, the flightcrew would have exceeded the flight and duty time requirements of 14 CFR Section 121.505.

7. The Department of Defense/Navy did not have a procedure in place at Guantanamo Bay to ensure that all air traffic controllers were made aware of the inoperative strobe light and to ensure

that the controllers communicated the operational status to flightcrews.

8. The captain did not recognize the deteriorating flightpath and airspeed conditions due to preoccupation with locating the strobe light on the ground. This lack of recognition was despite the conflicting remarks made by the first officer and the flight engineer questioning the success of the approach. Repeated callouts by the flight engineer stating slow airspeed conditions went unheeded by the captain.

9. The captain initiated the turn from base leg to final approach at an airspeed that was below the calculated reference speed of 147 KIAS, and less than 1,000 feet from the shoreline, and he allowed bank angles in excess of 50 degrees to develop.

10. The stall warning stick shaker had activated 7 seconds prior to impact, 5 seconds before the airplane reached stall speed.

11. There was no loss of roll authority at the onset of the artificial stall warning (stick shaker) and no evidence to indicate that the captain attempted to take proper corrective action at the onset of stick shaker.

12. AIA's management structure and philosophy were insufficient to maintain vigilant oversight and control of the rapidly expanding airline operation. This was substantiated by the inability of the Director of Operations to maintain aircraft flight manuals, crew training records, and various other required paperwork in an up-to-date and current status.

13. The surveillance and oversight of AIA by the FAA POI, PMI, and PAI were not totally effective because of the minimal to nonexistent FAA geographical support for oversight of the remote operations.

3.2 Probable Cause

The National Transportation Safety Board determines that the probable causes of this accident were the impaired judgment, decision-making, and flying abilities of the captain and flightcrew due to the effects of fatigue; the captain's failure to properly assess the conditions for landing and maintaining vigilant situational awareness of the airplane while maneuvering onto final approach; his failure to prevent the loss of airspeed and avoid a stall while in the steep bank turn; and his failure to execute immediate action to recover from a stall.

Additional factors contributing to the cause were the inadequacy of the flight and duty time regulations applied to 14 CFR, Part 121, Supplemental Air Carrier, international operations, and the circumstances that resulted in the extended flight/duty hours and fatigue of the flightcrew members. Also contributing were the inadequate crew resource management training and the inadequate training and guidance by American International Airways, Inc., to the flightcrew for operations at special airports, such as Guantanamo Bay; and the Navy's failure to provide a system that would assure that the local tower controller was aware of the inoperative strobe light so as to provide the flightcrew with such information.

4. RECOMMENDATIONS

As a result of the investigation of this accident, the National Transportation Safety Board makes the following recommendations:

--to the Federal Aviation Administration:

Revise the applicable subpart of 14 CFR, Part 121, to require that flight time accumulated in noncommercial "tail end" ferry flights conducted under 14 CFR, Part 91, as a result of 14 CFR, Part 121, revenue flights, be included in the flight crewmember's total flight and duty time accrued during those revenue operations. (Class II, Priority Action) (A-94-105)

Expedite the review and upgrade of Flight/Duty Time Limitations of the Federal Aviation Regulations to ensure that they incorporate the results of the latest research on fatigue and sleep issues. (Class II, Priority Action) (A-94-106)

Revise 14 CFR, Section 121.445, to eliminate subparagraph (c), and require that all flight crewmembers meet the requirements for operation to or from a special airport, either by operating experience or pictorial means. (Class II, Priority Action) (A-94-107)

--to American International Airways, Inc. (AIA):

Revise the AIA training program to ensure that all pilots receive crew resource management (CRM) training that conforms to the guidelines set forth in FAA Advisory Circular 120-51A. (Class II, Priority Action) (A-94-108)

Review and revise the AIA special airports training program to require, in addition to flightcrew members, flight engineers to participate in the AIA special airports training program. The revised program should ensure that all flightcrew members who operate airplanes with high approach speeds are aware and understand the effects of high bank angles and increased load factors, adverse wind conditions, and required flightpath profiles

necessary to perform the approach. (Class II, Priority Action) (A-94-109)

--to the Department of Defense:

Provide to all civilian contract operators and flightcrew members either verbal and/or written airfield briefing information regarding normal and emergency operations and flight restrictions pertaining to those airfields classified as "special airports." The briefing information would contain special considerations for airplanes with high approach speeds and emphasize the effects of high bank angles and increased load factors, adverse wind conditions, and required flightpath profiles necessary to perform the approach. This information would be provided in addition to the regularly published notices to airmen (NOTAMs). (Class II, Priority Action) (A-94-110)

In addition, the Safety Board reiterates the following safety recommendations to the Federal Aviation Administration:

A-94-2

Require U.S. air carriers operating under 14 CFR, Part 121, to provide for flightcrews not covered by the Advanced Qualifications Program, a comprehensive crew resource management (CRM) program as described in Advisory Circular 120-51A.

A-94-5

Require U.S. air carriers operating under 14 CFR, Part 121, to include, as part of pilot training, a program to educate pilots about the detrimental effects of fatigue, and strategies for avoiding fatigue and countering its effects.

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

Carl W. Vogt
Chairman

James E. Hall
Vice Chairman

John K. Lauber
Member

John Hammerschmidt
Member

May 10, 1994

5. APPENDIXES

APPENDIX A

INVESTIGATION AND HEARING

1. Investigation

The Safety Board's duty officer was notified by a representative of the Navy Safety Center, through the Federal Aviation Administration Communications Center in Washington, D.C., at approximately 1800 eastern daylight time on August 18, 1993.

Upon receiving additional information and a formal request from the Department of Defense and the Navy Safety Center to conduct the investigation, the Safety Board dispatched a partial investigative team from its Washington, D.C. Headquarters on August 19, 1993. The team was composed of an Investigator-in-Charge and the following group specialists: Systems, Powerplants, Survival Factors and Structures. In addition, specialist reports were prepared to summarize the findings relevant to Operations, Human Performance, Maintenance Records, FDR/Aircraft Performance and CVR. Chairman Carl Vogt accompanied the investigative team to Guantanamo Bay, Cuba.

Parties to the investigation were the FAA, American International Airways, the Teamsters Union, Douglas Aircraft Company, and the Department of Defense (DOD).

2. Public Hearing

A public hearing regarding this accident was held in Ypsilanti, Michigan, from January 5 through January 7, 1994. Member John Hammerschmidt was the presiding officer of that hearing.

APPENDIX B

COCKPIT VOICE RECORDER

Transcript of a Sundstrand AV-557B cockpit voice recorder (CVR), s/n 510, installed on a Douglas DC-8-61, N814CK, which was involved in a landing accident at Guantanamo Bay, NAS, Cuba, on August 18, 1993.

LEGEND

RDO	Radio transmission from accident aircraft
CAM	Cockpit area microphone voice or sound source
-1	Voice identified as Pilot-in-Command (PIC)
-2	Voice identified as Co-Pilot
-3	Voice identified as Flight Engineer
-?	Voice unidentified
MIA-1	Radio transmission from Miami ARTCC
MIA-2	Radio transmission from second controller at Miami ARTCC
GAPR	Radio transmission from Guantanamo NAS Approach Control
TWR	Radio transmission from Guantanamo NAS Control Tower
HEL	Radio transmission from helicopter six five six nine
*	Unintelligible word
@	Non pertinent word
#	Expletive
%	Break in continuity
( )	Questionable insertion
(( ))	Editorial insertion
- - -	Pause

Note: Times are expressed in eastern daylight time (EDT).
Times shown in brackets { } are computer reference times.

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME & SOURCE	CONTENT	TIME & SOURCE	CONTENT

START OF RECORDING

START OF TRANSCRIPT

1623:23 {02:56}
CAM-1 get a fuel check over this next station here uh, fifty nine minutes by seven minutes. ---- ten and a half minutes.

1628:27 {08:00}
CAM-1 **** do it. comin' down this way. around?

1628:31 {08:04}
CAM-2 around the coast.

1628:31 {08:04}
CAM-2 you're coming down like this.

1628:33 {08:06}
CAM-1 ya. ** Guantanamo ***.

1628:37 {08:10}
CAM-? oh, OK. ***.

1628:41 {08:14}
CAM-2 direct, direct, direct. we also get another direct.

1629:25 {08:58}
CAM-1 did you ever land it the other way, on two eight?

1629:30 {09:03}
CAM-3 suppose to be a tail wind.

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME & SOURCE	CONTENT	TIME & SOURCE	CONTENT
1629:30 **CAM-1**	{09:03} huh?		
1629:31 **CAM-3**	{09:04} suppose to be a tail wind.		
1629:35 **CAM-1**	{09:08} (we've) always flown hard deck.		
1629:37 **CAM-2**	{09:10} not always. I mean if the wind's not blowing our way, we'll just request uh, two eight.		
1629:56 **CAM-1**	{09:29} you get a fuel check out of there Dave. if you want to.		
1630:26 **CAM-3**	{09:59} thirty eight two.		
1630:28 **CAM-?**	{10:01} ***.		
1630:30 **CAM-1**	{10:03} before you write that down, look and see how ***.		
1630:34 **CAM-3**	{10:07} that's right.		
1630:36 **CAM-2**	{10:09} thirty eight.		
1630:36 **CAM-1**	{10:09} let's put thirty nine.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME & SOURCE	CONTENT	TIME & SOURCE	CONTENT
1630:38 {10:11} **CAM-3**	thirty eight two, confirmed.		
1630:39 {10:12} **CAM-?**	ya.		
1630:40 {10:13} **CAM-?**	OK.		
1630:48 {10:21} **CAM-2**	OK uh, we're just went over uh, Great Inagua?		
1630:52 {10:25} **CAM-1**	ya.		
1630:59 {10:32} **CAM-2**	BYGON. -- we're now, hundred and forty three miles from destination.		
1631:06 {10:39} **CAM-1**	how far?		
1631:07 {10:40} **CAM-2**	hundred forty three miles. --- start down in about twenty miles, probably?		
1631:25 {10:58} **CAM-?**	I don't believe that radar is right, is it?		
1631:28 {11:01} **CAM-1**	go to a closer range.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME & SOURCE	CONTENT	TIME & SOURCE	CONTENT
1631:29	{11:02}		
CAM-2	# even at close range it's still.		
1631:31	{11:04}		
CAM-1	you got it in map mode, huh?		
1631:42	{11:15}		
CAM-2	no, **** map mode.		
1631:45	{11:18}		
CAM-?	here you go see.		
1631:46	{11:19}		
CAM-1	showin' the same, same thing on map as it is uh, didn't switch over.		
1631:54	{11:27}		
CAM-?	OK, let's uh, go to uh, waypoint. BYGON *****.		
1632:02	{11:35}		
CAM-2	there's BYGON.		
1632:17	{11:50}		
CAM-1	wonder if we talk to Cuba at all? we talk to Cuban uh, approach at all?		
1632:22	{11:55}		
CAM-2	should be.		
1632:26	{11:59}		
CAM-1	we're goin to be at their airspace here in a little bit.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME & SOURCE	CONTENT	TIME & SOURCE	CONTENT
1632:30 CAM-2	{12:03} I'll, I'll get a word in edgewise here.		
		1632:39 RDO-2	{12:12} Miami, Connie eight oh eight heavy, over, -- break, Connie eight zero eight uh, we'd like to have uh, information on a switch over for, Guantanamo.
		1632:49 MIA-1	{12:22} Connie eight zero eight roger, you mean uh, the procedures for that?
		1632:53 RDO-2	{12:26} yes, we'd like have anticipate, we're not gonna have room from the descent and switch over.
		1632:59 MIA-1	{12:32} Connie eight zero eight Roger, right now your clearance limit is BYGON intersection uh, I'll need a cancellation prior to that, I can't clear you past BYGON. That's in Havana's airspace. and then uh, you cancel and you talk to Guantanamo radar.
		1633:12 RDO-2	{12:45} do you have their frequency you gonna give to us?
1633:17 CAM-1	{12:50} she can clear us start clearing us down now.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME & SOURCE	CONTENT	TIME & SOURCE	CONTENT
		1633:19 **MIA-2**	{12:52} ya the, frequency is one two six point two. one three four point one, one three four point one is the frequency.
		1633:28 **RDO-2**	{13:01} roger, one three four point one and uh confirm we have to cancel before we can get lower.
		1633:33 **MIA-1**	{13:06} Connie eight zero eight, I can descend you but I cannot let you go past BYGON unless you cancel with me.
		1633:38 **RDO-2**	{13:11} OK, we'd like to descend and uh, we'll uh, stand by for cancel, eight zero eight.
		1633:47 **MIA-1**	{13:20} Connie eight zero eight roger, descend and maintain flight level one eight zero.
1633:53 **CAM**	{13:26} ((sound similar to landing gear warning horn))		
		1633:55 **RDO-2**	{13:28} OK, to one eight zero, Connie uh, eight zero eight heavy.
1633:59 **CAM-1**	{13:32} * BYGON, what number did you put BYGON on?		
1634:02 **CAM-2**	{13:35} uh, BYGON is on uh,		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME & SOURCE	CONTENT	TIME & SOURCE	CONTENT
1634:03 CAM-1	{13:36} five?		
1634:03 CAM-2	{13:36} four.		
1634:04 CAM-1	{13:37} four?		
1634:05 CAM-2	{13:38} we just passed it.		
1634:09 CAM-1	{13:42} coming up on it right now.		
1634:10 CAM-2	{13:43} ya.		
1634:11 CAM-1	{13:44} ** cancel.		
1634:12 CAM-2	{13:45} ya.		
		1634:13 RDO-2	{13:46} Connie eight zero eight heavy like to cancel.
1634:16 CAM-1	{13:49} ask him if we need to call **.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME & SOURCE	CONTENT	TIME & SOURCE	CONTENT
		1634:17 **MIA-1**	{13:50} Connie eight zero eight heavy, cancellation received. squawk one two zero zero, and uh, frequency change approved.
1634:23 **CAM-?**	{13:56} * * *.		
1634:23 **CAM-1**	{13:56} ** if we need to call Cuba at all? --- wonder if we need to call Cuba at all?		
		1634:26 **RDO-2**	{13:59} One thirty four point one and uh, we'll switch over there right now.
		1634:33 **RDO-2**	{14:06} Havana center, Connie eight zero eight heavy uh, checking in, and we're descending out of three uh, two zero for one eight zero.
1634:48 **CAM-?**	{14:21} * * * *.		
1634:48 **CAM-?**	{14:21} BYGON here.		
		1634:49 **GAPR**	{14:22} and uh, Connie eight zero eight heavy, Guantanamo radar.
		1634:55 **RDO-2**	{14:28} roger, we receive you Connie uh, eight zero eight heavy, go ahead Havana.

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME & SOURCE	CONTENT	TIME & SOURCE	CONTENT
1635:00 **CAM-1**	{14:33} Guantanamo radar, not Havana.		
		1635:02 **GAPR**	{14:35} Connie eight zero eight heavy this is Guantanamo radar. understand you're comin' to Guantanamo Bay?
		1635:06 **RDO-2**	{14:39} that's affirmative Connie eight zero eight heavy uh, we're goin' to Guantanamo uh, Guantanamo Bay.
		1635:17 **GAPR**	{14:50} uh, Connie eight zero eight heavy, understand you're just uh, five miles south of BYGON at this time.
		1635:24 **RDO-1**	{14:57} affirmative uh, comin' up on BYGON now.
		1635:28 **GAPR**	{15:01} Connie eight zero eight heavy, Guantanamo radar, maintain the VFR one two miles off the Cuban coast. no reported traffic in the area. report East Point. Leeward field landing one zero, wind one, eight zero at eight. altimeter's two niner niner seven.
		1635:45 **RDO-2**	{15:18} one eight zero at eight two niner niner seven and uh, like to land two eight.

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME & SOURCE	CONTENT	TIME & SOURCE	CONTENT
		1635:52 {15:25} **GAPR**	Connie eight zero eight heavy, Guantanamo roger, two eight is available.
		1635:57 {15:30} **RDO-2**	roger, two eight is available and uh, when do you want us to report off uh, of the approach.
		1636:03 {15:36} **GAPR**	Connie eight zero eight heavy, report East Point. zero nine five at zero seven zero.
1636:11 {15:44} **CAM-1**	zero nine five zero seven zero, I don't know what he meant by that.		
		1636:13 {15:46} **RDO-2**	((concurrent with previous statement)) what do you mean by that, uh, uh, clarify?
		1636:18 {15:51} **GAPR**	Connie eight zero eight heavy. report uh, East Point.
1636:23 {15:56} **CAM-1**	right here ** East Point.		
		1636:24 {15:57} **GAPR**	East Point is the NBW zero nine zero uh, radial at zero seven zero DME.
		1636:29 {16:02} **RDO-2**	OK, E Point, roger Connie eight zero eight heavy.

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME & SOURCE	CONTENT	TIME & SOURCE	CONTENT
1636:34 CAM-1	{16:07} the zero nine zero radial of what? Guantanamo?		
		1636:37 RDO-2	{16:10} and confirm that zero nine zero radial seventy miles of uh, Guantanamo?
		1636:45 GAPR	{16:18} and zero eight zero that's affirmative, affirmative, do you have a fuel request?
		1636:49 RDO-2	{16:22} * fourteen six, we'll dial it in
1636:54 CAM-1	{16:27} ask him if we need to contact at Cuba at all.		
		1636:58 RDO-2	{16:31} and uh, confirm uh, uh, no requirements for Connie eight zero eight heavy to uh, contact uh, Havana.
		1637:07 GAPR	{16:40} Connie eight zero eight heavy Guantanamo radar, say again.
		1637:11 RDO-2	{16:44} uh, Connie eight zero eight heavy uh, will remain uh, off shore and uh, is there any requirements us to contact Guan-, uh, Havana center?

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME & SOURCE	CONTENT	TIME & SOURCE	CONTENT
		1637:22 {16:55} **GAPR**	Connie eight zero eight, negative.
		1637:24 {16:57} **RDO-2**	roger.
1637:29 {17:02} **CAM-1**	what's Guantanamo's frequency?		
1637:30 {17:03} **CAM-2**	Guantanamo's twelve, it's uh, fourteen six.		
1637:37 {17:10} **CAM-1**	uh, *** it's number five isn't it?. it's number five.		
1637:42 {17:15} **CAM-2**	correct, affirmative.		
1637:50 {17:23} **CAM-1**	OK, we wanna go to (E Point).		
1637:54 {17:27} **CAM-?**	everybody listen up.		
1637:55 {17:28} **CAM-1**	no, we're gonna be at (E Point) now, and then we're gonna go to Delta.		
1637:59 {17:32} **CAM-2**	(we're comin') up on it now.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME & SOURCE	CONTENT	TIME & SOURCE	CONTENT
1638:07 **CAM-1**	{17:40} we're crossing it right now, seventy degrees at nine miles. zero nine zero *****.		
		1638:11 **RDO-2**	{17:44} Connie eight zero eight heavy is uh, crossing East Point at the present time and we're out of twenty two uh, point three descending to one eight oh.
		1638:22 **GAPR**	{17:55} and eight zero eight heavy roger, maintain VFR six miles off the Cuban coast, no observed traffic, report two five DME.
		1638:28 **RDO-2**	{18:01} roger, report two five DME and uh, twelve miles off the coast uh, Connie eight zero eight heavy.
		1638:33 **GAPR**	{18:06} Connie eight zero eight heavy, that is six miles off the coast. understand you had no fuel request?
		1638:39 **RDO-2**	{18:12} we're gonna need refueling. uh, we'll give that to you on the ground.
		1638:44 **GAPR**	{18:17} eight zero eight heavy, roger.
1638:50 **CAM-?**	{18:23} it's still approach control.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME & SOURCE	CONTENT	TIME & SOURCE	CONTENT
1639:08 CAM-2	{18:41} give yourself some slack on this uh, **** the coast.		
1639:22 CAM-?	{18:55} *** (wanna get) too close.		
1639:28 CAM-?	{19:01} DELTA ** off the coast. south southeast of uh, the airport.		
1639:36 CAM-1	{19:09} looks like twelve miles?		
1639:38 CAM-2	{19:11} easily, yes easily, and ---.		
1639:44 CAM	{19:17} ((sound of warning horn similar to altitude alert))		
1639:45 CAM-2	{19:18} ****** bring it right down here uh, ** safe vector altitude is uh, twenty five hundred feet. *** bring it right down to twenty five hundred feet.		
1640:00 CAM-3	{19:33} are they giving us two eight?		
1640:02 CAM-1	{19:35} ya. if it's available.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME & SOURCE	CONTENT	TIME & SOURCE	CONTENT
1640:07 {19:40} **CAM-2**	transition alt -, level is fifty five hundred feet.		
1640:15 {19:48} **CAM-1**	descent checks.		
1640:16 {19:49} **CAM-3**	PTC?		
1640:17 {19:50} **CAM-1**	retracted override.		
1640:19 {19:52} **CAM-3**	altimeters.		
1640:22 {19:55} **CAM-?**	two nine nine **.		
1640:24 {19:57} **CAM-?**	that's it.		
1640:29 {20:02} **CAM-1**	set on the left, one forty uh, seven.		
1641:00 {20:33} **CAM-2**	you're almost due east of Delta, you're in good shape. you're right about here. abeam the Delta. right about here. abeam of the Delta. ** forty two miles.		
1641:41 {21:14} **CAM-?**	lookin' good.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME & SOURCE	CONTENT	TIME & SOURCE	CONTENT
1641:53 **CAM-1**	{21:26} otta make that one zero approach just for the heck of it to see how it is. why don't we do that let's, tell 'em we'll take one zero. if we miss it we'll just come back around and land on two eight.		
1642:04 **CAM-2**	{21:37} OK.		
		1642:05 **RDO-2**	{21:38} uh, Guantanamo uh, this is Connie eight zero eight heavy.
		1642:16 **GAPR**	{21:49} Connie eight zero eight heavy, Guantanamo go ahead.
		1642:18 **RDO-2**	{21:51} uh, Co -, eight zero eight heavy. requesting uh, land uh, east and uh, if we uh, need to, we'll uh, make another approach uh, but we'd like to make the first uh, approach anyway uh, to uh, the east th -, this afternoon.
		1642:40 **GAPR**	{22:13} and Connie eight zero eight, understand you'd like to make your first approach to runway one zero.
		1642:44 **RDO-2**	{22:17} that's affirmative, Connie eight zero eight heavy, runway one zero.

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME & SOURCE	CONTENT	TIME & SOURCE	CONTENT
		1642:48 **GAPR**	{22:21} roger, you want uh, left entry or right entry.
1642:52 **CAM-1**	{22:25} * we have a left?		
1642:53 **CAM-?**	{22:26} we're not authorized for it.		
		1642:54 **RDO-2**	{22:27} make a right entry, Connie eight zero eight heavy.
		1642:56 **GAPR**	{22:29} eight zero eight heavy roger.
1642:58 **CAM-2**	{22:31} *** we're not authorized to do it.		
1643:00 **CAM-1**	{22:33} not authorized?		
1643:01 **CAM-1**	{22:34} he's not, he's not -- aware of that, Tom.		
1643:04 **CAM-1**	{22:37} no notes or nothing.		
1643:06 **CAM-1**	{22:39} it does say right hand traffic in the, in that uh, training clip that's all it says.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME & SOURCE	CONTENT	TIME & SOURCE	CONTENT
1643:12 {22:45} **CAM-2**	right, I know for sure uh, 'cause I, I just went through recurrent. ---- besides there's a big hill over there. it might give you some -- some depth perception problems.		
1643:30 {23:03} **CAM-3**	is there weather down there at all?		
1643:32 {23:05} **CAM-1**	ah, no.		
		1643:33 {23:06} **RDO-2**	and Connie eight zero eight heavy uh, request uh, weather conditions, sky conditions, and visibility.
		1643:41 {23:14} **GAPR**	Connie eight zero eight heavy uh, standby. ---- and uh, correction, Connie eight zero eight heavy, sky conditions last reported at * thousand scattered, one zero thousand scattered, two zero thousand overcast, visibility was seven.
		1644:08 {23:41} **RDO-2**	roger ah, Connie eight zero eight heavy, thank you.
1644:11 {23:44} **CAM-1**	what was his first, comment?		
1644:12 {23:45} **CAM-2**	scattered, scattered.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME & SOURCE	CONTENT	TIME & SOURCE	CONTENT
1644:13 {23:46} **CAM-?**	one thousand.		
1644:14 {23:47} **CAM-?**	ten thousand scattered, seven miles visibility.		
1644:17 {23:50} **CAM-?**	right.		
		1644:22 {23:55} **RDO-2**	and what is the local altimeter approach uh, Connie eight zero eight heavy?
		1644:26 {23:59} **GAPR**	two niner niner seven.
		1644:27 {24:00} **RDO-2**	thank you.
1644:32 {24:05} **CAM-1**	we got the descent check, didn't we?		
1644:33 {24:06} **CAM-3**	complete. well, I got the new altimeter here.		
1644:38 {24:11} **CAM-2**	this uh, transition level is fifty five hundred ***.		
1644:41 {24:14} **CAM-1**	that's alright. it ain't going to matter.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME & SOURCE	CONTENT	TIME & SOURCE	CONTENT
1644:50 **CAM-3**	{24:23} just don't do no rolls on final.		
1644:53 **CAM-2**	{24:26} ***** --- wanna make sure you're wings level and you're on center line because you have those uh, VASIs there, for catching.		
1645:12 **CAM-2**	{24:45} wants a call twenty five out.		
1645:14 **CAM-1**	{24:47} twenty five out, ya.		
1645:20 **CAM-?**	{24:53} *** there.		
1645:21 **CAM-1**	{24:54} huh?		
1645:23 **CAM-?**	{24:56} ****.		
1645:27 **CAM**	{25:00} ((sound similar to trim-in-motion horn))		
		1645:38 **RDO-2**	{25:11} and Connie eight zero eight heavy is comin' up on uh, twenty six out, out of uh, eighty five hundred.

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME & SOURCE	CONTENT	TIME & SOURCE	CONTENT
		1645:44 GAPR	{25:17} Connie eight zero eight roger, maintain VFR, no traffic observed, go contact tower.
		1645:51 RDO-2	{25:24} roger, contact tower, Connie eight zero eight heavy.
1645:54 CAM-?	{25:27} tower is twenty six two.		
		1646:01 RDO-2	{25:34} Guantanamo uh, tower this is Connie eight zero eight heavy uh, we're twenty five miles out.
		1646:07 TWR	{25:40} Connie, eight oh eight heavy, Leeward tower, runway one zero, wind two zero zero at seven, altimeter two niner niner seven. report Point Alpha.
		1646:18 RDO-2	{25:51} OK, report uh, --
1646:19 CAM-1	{25:52} Point Alpha.		
		1646:20 RDO-2	{25:53} point ALPHA, uh, we need a clarification where that point Alpha is.
		1646:26 TWR	{25:59} ALPHA is one two five at one zero DME.

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME & SOURCE	CONTENT	TIME & SOURCE	CONTENT
		1646:29 **RDO-2**	{26:02} one two five at one zero, Connie eight uh, zero eight heavy.
1646:31 **CAM-1**	{26:04} ((concurrent with previous statement)) one two five radial?		
		1646:32 **TWR**	{26:05} eight zero eight, would you uh, like runway two eight?
1646:36 **CAM-1**	{26:09} we're gonna try ten first.		
		1646:39 **RDO-2**	{26:12} we're gonna try ten first uh, Connie eight zero eight heavy.
1646:41 **CAM-1**	{26:14} flaps twenty uh, fifteen approach check.		
		1646:43 **TWR**	{26:16} eight zero eight roger.
1646:44 **CAM**	{26:17} ((sound similar to landing gear warning horn))		
1646:46 **CAM-3**	{26:19} an what did he say them winds were?		
1646:49 **CAM-1**	{26:22} zero, one zero, either one eight zero or one zero zero.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME & SOURCE	CONTENT	TIME & SOURCE	CONTENT
		1646:50 **HEL**	{26:23} Leeward tower, Coast Guard six five six nine, holding short of runway one zero, (for some) VFR southeast bound, negative return to mother.
		1646:54 **TWR**	{26:27} Coast Guard six five six nine Leeward tower, make a right turn out and proceed on course. winds one nine zero at eight cleared for takeoff, caution men and equipment, left hand side midfield.
1646:59 **CAM-2**	{26:32} what's that fix she gave us again ***?		
1647:00 **CAM-1**	{26:33} I thought she said one twenty five.		
1647:02 **CAM-3**	{26:35} one ninety.		
1647:03 **CAM-1**	{26:36} huh?		
1647:03 **CAM-3**	{26:36} at twelve.		
1647:04 **CAM-3**	{26:37} one twenty five at twelve DME. that what you got?		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME & SOURCE	CONTENT	TIME & SOURCE	CONTENT
1647:08 {26:41} **CAM-1**	I don't know.		
		1647:09 {26:42} **RDO-2**	and uh, Connie eight zero eight heavy is that one twenty five degrees at ten DME at point ALPHA.
		1647:14 {26:47} **TWR**	affirmative, understand you're at point ALPHA?
1647:16 {26:49} **CAM-1**	no.		
		1647:17 {26:50} **RDO-2**	not, not quite. uh, we're still a few miles out.
		1647:19 {26:52} **TWR**	((simultaneous with next statement)) eight oh eight, roger.
1647:20 {26:53} **CAM-?**	* *		
1647:22 {26:55} **CAM-1**	well I'm past that radial.		
1647:22 {26:55} **CAM-2**	we, got the, the route coordinates.		
1647:24 {26:57} **CAM-1**	as soon as I pass that point ALPHA. I'll ---		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME & SOURCE	CONTENT	TIME & SOURCE	CONTENT
1647:32 {27:05} **CAM-2**	OK, one twenty five radial --- makes that the three oh five inbound.		
1647:38 {27:11} **CAM-1**	three oh five inbound, huh?		
1647:43 {27:16} **CAM**	((sound similar to course selector being turned))		
1647:53 {27:26} **CAM-3**	it's hazy over there.		
1647:54 {27:27} **CAM-2**	sure as # is.		
1648:05 {27:38} **CAM-1**	twenty five degrees.		
1648:06 {27:39} **CAM-2**	set.		
1648:07 {27:40} **CAM**	((sound similar to flap handle being moved))		
1648:19 {27:52} **CAM-3**	visibility should pick up the closer to the surface.		
1648:21 {27:54} **CAM-1**	yeah.		
1648:22 {27:55} **CAM-?**	yeah.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME & SOURCE	CONTENT	TIME & SOURCE	CONTENT
1648:24 {27:57}			
CAM-?	not much. ((sound of chuckle))		
1648:40 {28:13}			
CAM-1	go back to that intersection we're going to.		
1648:43 {28:16}			
CAM-2	we just, flipped over.		
1648:45 {28:18}			
CAM-1	alright. put the airport in there then?		
1648:46 {28:19}			
CAM-3	there's the airport straight ahead.		
1648:48 {28:21}			
CAM-1	huh?		
1648:49 {28:22}			
CAM-2	MUGM is right here.		
1648:50 {28:23}			
CAM-3	fourteen miles, --- straight off the nose.		
1649:01 {28:34}			
CAM-1	OK, three nineteen.		
1649:07 {28:40}			
CAM-?	oh I got my * land.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME & SOURCE	CONTENT	TIME & SOURCE	CONTENT
1649:08 **CAM-2**	{28:41} there's the, there's the uh, right side of the uh, land mass and the bay that goes through. we're going to be shootin' off to the left of it.		
1649:19 **CAM-2**	{28:52} and we're goin' to be comin' in uh, inbound about fourteen miles out. the airport on this uh,		
1649:23 **CAM-1**	{28:56} the airport's gonna to be on that side of the bay.		
1649:26 **CAM-3**	{28:59} we're gonna come back around and hang a right.		
1649:27 **CAM-?**	{29:00} ya, that's right.		
		1649:28 **TWR**	{29:01} Coast Guard six five six niner, report leaving the ATA.
		1649:31 **HEL**	{29:04} six five six nine, wilco.
1649:31 **CAM-3**	{29:04} we're on downwind pretty much right now, aren't we?		
1649:33 **CAM-1**	{29:06} yeah.		
1649:33 **CAM-2**	{29:06} yeah.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME & SOURCE	CONTENT	TIME & SOURCE	CONTENT
1649:34 {29:07} CAM-?	we're gonna have to get ***.		
1649:35 {29:08} CAM-?	** over. ** get back over.		
1649:35 {29:08} CAM-?	I'm like ***		
1649:36 {29:09} CAM	((sound similar to altitude warning horn))		
1649:38 {29:11} CAM-?	three for twenty five.		
1649:40 {29:13} CAM-?	let's go down to fifteen.		
		1649:41 {29:14} RDO-2	Connie eight zero eight heavy is at twelve miles out uh, anda' we're on the uh, one uh, four zero radial.
		1649:49 {29:22} TWR	Connie eight zero eight heavy roger, report abeam the tower.
		1649:54 {29:27} RDO-2	OK, report abeam the tower, Connie eight zero eight heavy.
1649:58 {29:31} CAM-1	report abeam the tower?		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME & SOURCE	CONTENT	TIME & SOURCE	CONTENT
		1649:59 TWR	{29:32} Coast Guard six five six niner remain at or below five hundred feet until departing the ATA.
1650:00 CAM-?	{29:33} yeah.		
1650:01 CAM-?	{29:34} abeam the tower.		
1650:03 CAM-3	{29:36} yeah that's affirm.		
		1650:03 HEL	{29:36} ((simultaneous with previous two statements)) six five six nine wilco, we're level at five hundred at this time and we'll be looking for the heavy.
1650:05 CAM-1	{29:38} you say the airport's on the other side?		
1650:06 CAM-2	{29:39} yes.		
1650:07 CAM-3	{29:40} it's on that side there, yes.		
1650:08 CAM-?	{29:41} here's that bay. you gotta come over here, and lead in.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME & SOURCE	CONTENT	TIME & SOURCE	CONTENT
1650:10 **CAM-?**	{29:43} OK, I see that.		
		1650:10 **TWR**	{29:43} six five six niner roger, and Connie eight oh eight, traffic is H65 outbound for the southeast at or below five hundred feet.
1650:14 **CAM-2**	{29:47} so what I'm gonna do is set this up to about uh,		
1650:17 **CAM-3**	{29:50} that's for us.		
		1650:18 **RDO-1**	{29:51} say again where the traffic was for Connie eight oh eight.
		1650:21 **TWR**	{29:54} he's about three miles to the southeast off departure end outbound, at or below five hundred feet.
1650:27 **CAM**	{30:00} ((sound similar to altitude warning horn))		
1650:28 **CAM-3**	{30:01} at or below five hundred, huh.		
1650:29 **CAM**	{30:02} ((sound similar to course selector being turned))		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME & SOURCE	CONTENT	TIME & SOURCE	CONTENT
1650:36 **CAM-2**	{30:09} use this. this will tell you when you're due south of the airport.		
1650:39 **CAM-1**	{30:12} I'm just gonna follow that right to the airport regardless.		
1650:43 **CAM-2**	{30:16} just swing over, then make sorta', square it off.		
1650:46 **CAM-?**	{30:19} yeah.		
1650:48 **CAM-2**	{30:21} but when this says three six zero you know, you're south, due south of the airport.		
		1650:55 **TWR**	{30:28} Connie eight oh eight, the H65 has you in sight.
		1650:57 **RDO-2**	{30:30} Connie eight zero eight heavy, roger.
1651:02 **CAM-3**	{30:35} what is it, a helicopter?		
1651:02 **CAM-?**	{30:35} yeah, it must be.		
1651:03 **CAM-3**	{30:36} there's a big hill over there man.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME & SOURCE	CONTENT	TIME & SOURCE	CONTENT
1651:05 CAM-?	{30:38} yeah, it sure is. look at that ###.		
1651:07 CAM-1	{30:40} wonder if that's the airport right there straight ahead of us?		
1651:10 CAM-2	{30:43} that is the airport straight ahead of us. see the lake on the other side.		
1651:15 CAM-3	{30:48} ** six miles, that's gotta be it.		
1651:17 CAM-2	{30:50} that's the lake on the other side of the airport.		
1651:18 CAM-1	{30:51} this thing here is just about dead nuts.		
1651:20 CAM-?	{30:53} yeah.		
1651:20 CAM-?	{30:53} yeah.		
1651:21 CAM-3	{30:54} *** little right of course.		
1651:22 CAM-1	{30:55} huh.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME & SOURCE	CONTENT	TIME & SOURCE	CONTENT
1651:23 CAM-3	{30:56} just a little right of course.		
1651:24 CAM-1	{30:57} yeah.		
1651:27 CAM-2	{31:00} you're uh, fourteen hundred feet. turbojet circling minimum situation.		
1651:37 CAM-2	{31:10} you wanna get all dirty and slowed down and everything?		
1651:39 CAM-1	{31:12} oh I will, yeah.		
1651:40 CAM-?	{31:13} OK.		
1651:45 CAM-1	{31:18} OK there, that's the end of the runway, right there.		
1651:47 CAM-?	{31:20} yeah, it's two eight.		
1651:50 CAM-2	{31:23} I'd give myself plenty of time to get straight *.		
1651:54 CAM-3	{31:27} nice **, huh?		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME & SOURCE	CONTENT	TIME & SOURCE	CONTENT
1651:54 **CAM-1**	{31:27} huh?		
1651:56 **CAM-2**	{31:29} maintain a little water off because you're gonna have to turn.		
		1652:03 **TWR**	{31:36} Connie eight oh eight, *, Cuban airspace begins three quarters of a mile west of the runway. you are required to remain within this, within the airspace designated by a strobe light.
		1652:14 **RDO-2**	{31:47} roger, we'll look for the strobe light, Connie eight zero eight heavy.
1652:17 **CAM-2**	{31:50} I think you're gettin' in close, before you start your turn.		
1652:20 **CAM-3**	{31:53} yeah, the runway's right here man.		
1652:21 **CAM-1**	{31:54} yeah, I got it. yeah, I got it.		
1652:22 **CAM-3**	{31:55} you're right on it.		
1652:23 **CAM-1**	{31:56} * going to have to really honk it. let's get the gear down **.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME & SOURCE	CONTENT	TIME & SOURCE	CONTENT
1652:25 **CAM-2**	{31:58} alright.		
1652:27 **CAM**	{32:00} ((sound similar to landing gear being extended))		
1652:36 **CAM-3**	{32:09} gear's down.		
1652:37 **CAM-1**	{32:10} the trouble is, I can't see the --		
1652:41 **CAM-2**	{32:14} there's the runway right there.		
1652:43 **CAM-3**	{32:16} see that black strip right there.		
		1652:43 **TWR**	{32:16} eight zero eight, we have a crane off to the left side, midfield 'bout thirty five feet. can you land with it raised or do we need to lower it?
1652:49 **CAM-1**	{32:22} can't understand her.		
		1652:49 **RDO-2**	{32:22} can't understand, you're garbled.
1652:52 **CAM-?**	{32:25} twenty for thirty five.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME & SOURCE	CONTENT	TIME & SOURCE	CONTENT
1652:53 **CAM**	{32:26} ((sound of click similar to flap handle being moved))		
		1652:55 **TWR**	{32:28} eight zero eight we have a crane off to the left side of the runway midf --, correction off the left side of the runway midfield, lowering, at from thirty five feet. can you land from there or do you need him to move?
1653:04 **CAM-1**	{32:37} ah, he'll be alright. ((simultaneous with following statement))		
		1653:05 **RDO-2**	{32:38} ah, how clo -, close is he to your runway? he should be OK.
1653:08 **CAM-1**	{32:41} flaps fifty.		
1653:08 **CAM-2**	{32:41} OK.		
1653:09 **CAM-?**	{32:42} K, uh.		
		1653:10 **TWR**	{32:43} he's cleared of runway. he's about couple of feet off the runway.
1653:11 **CAM**	{32:44} ((sound similar to trim-in-motion horn))		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME & SOURCE	CONTENT	TIME & SOURCE	CONTENT
1653:12 **CAM-1**	{32:45} now we gotta stay on uh, one side of this road here, right?		
1653:15 **CAM-2**	{32:48} yeah, we gotta stay on this side, on this side over here. you can see the strobe lights.		
1653:19 **CAM**	{32:52} ((sound similar to increase in engine RPM))		
		1653:20 **TWR**	{32:53} eight zero eight, check wheels down wind at two zero zero ((balance of this transmission overridden by next transmission))
		1653:21 **RDO-2**	{32:54} we're abeam the airport, Connie eight zero eight heavy.
1653:22 **CAM-3**	{32:55} slow. airspeed.		
1653:25 **CAM-2**	{32:58} check the turn.		
1653:28 **CAM-1**	{33:01} where's the strobe?		
1653:29 **CAM-3**	{33:02} right over there.		

INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME & SOURCE	CONTENT	TIME & SOURCE	CONTENT
1653:31 {33:04} CAM-1	where?		
1653:33 {33:06} CAM-2	right inside there, right inside there.		
1653:35 {33:08} CAM-3	you know, we're not gettin' our airspeed back there.		
1653:36 {33:09} CAM-?	*		
1653:37 {33:10} CAM-1	where's the strobe.		
1653:37 {33:10} CAM-2	right down there.		
1653:41 {33:14} CAM-1	I still don't see it.		
1653:42 {33:15} CAM-3	#, we're never goin' to make this.		
1653:43 {33:16} CAM-1	huh.		
1653:45 {33:18} CAM-1	where do you see a strobe light?		
1653:48 {33:20} CAM	((sound similar to decrease in engine RPM))		

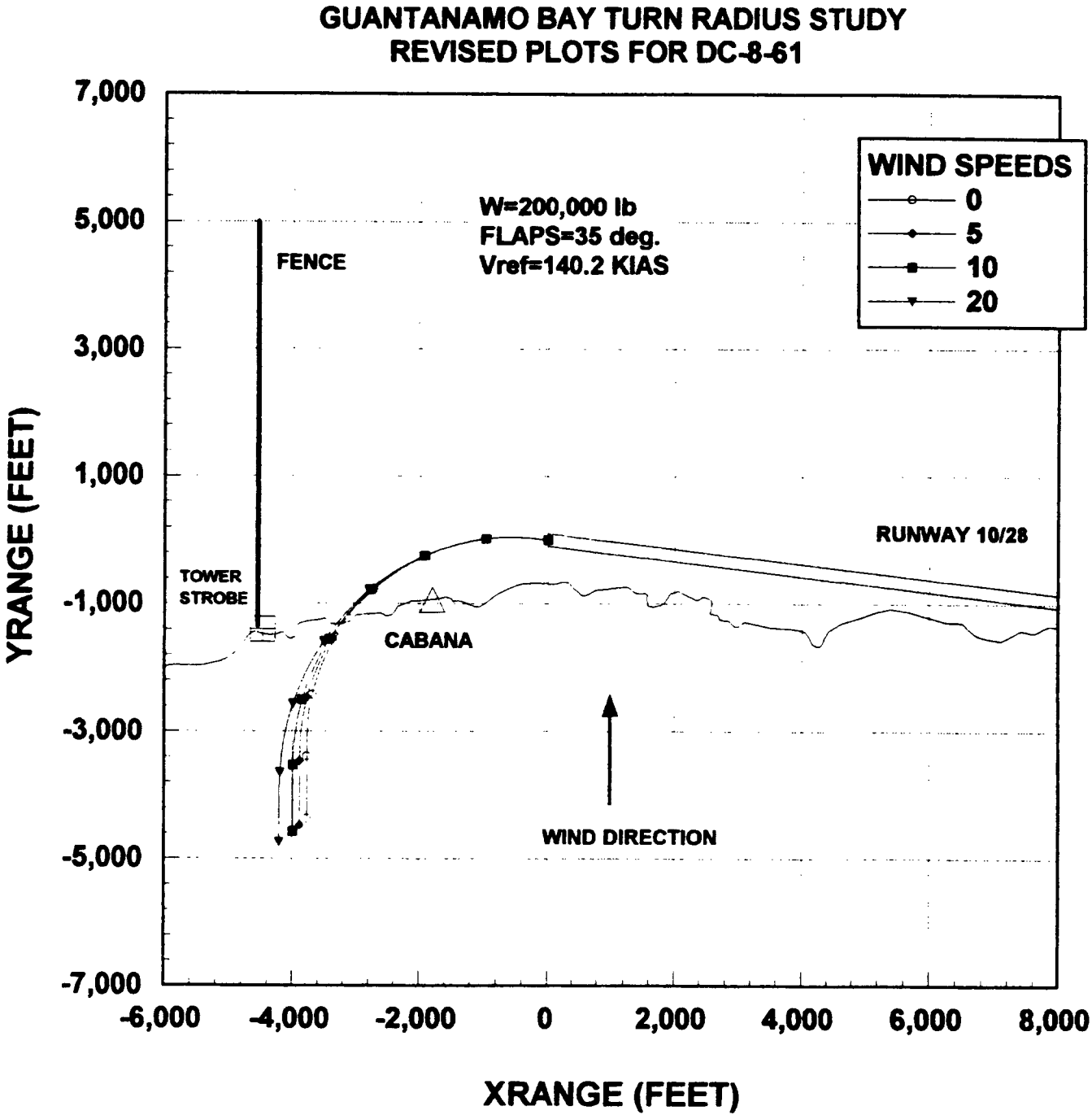
INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME & SOURCE	CONTENT	TIME & SOURCE	CONTENT
1653:48 CAM-2	{33:21} right over here.		
1653:49 CAM	{33:22} ((sound similar to altitude warning horn))		
1653:50 CAM-?	{33:23} ** alright.		
1653:51 CAM-1	{33:24} gear, gear down, spoilers armed.		
1653:52 CAM-3	{33:25} gear down three green, spoilers, flaps, check list.		
1653:55 CAM-?	{33:28} there you go, right there lookin' good.		
1653:57 CAM-1	{33:30} where's the strobe?		
1653:58 CAM-2	{33:31} do you think you're gonna make this?		
1653:58 CAM-1	{33:31} yeah.		
1654:00 CAM-1	{33:33} if I can catch the strobe light.		
1654:01 CAM-2	{33:34} five hundred, you're in good shape.		

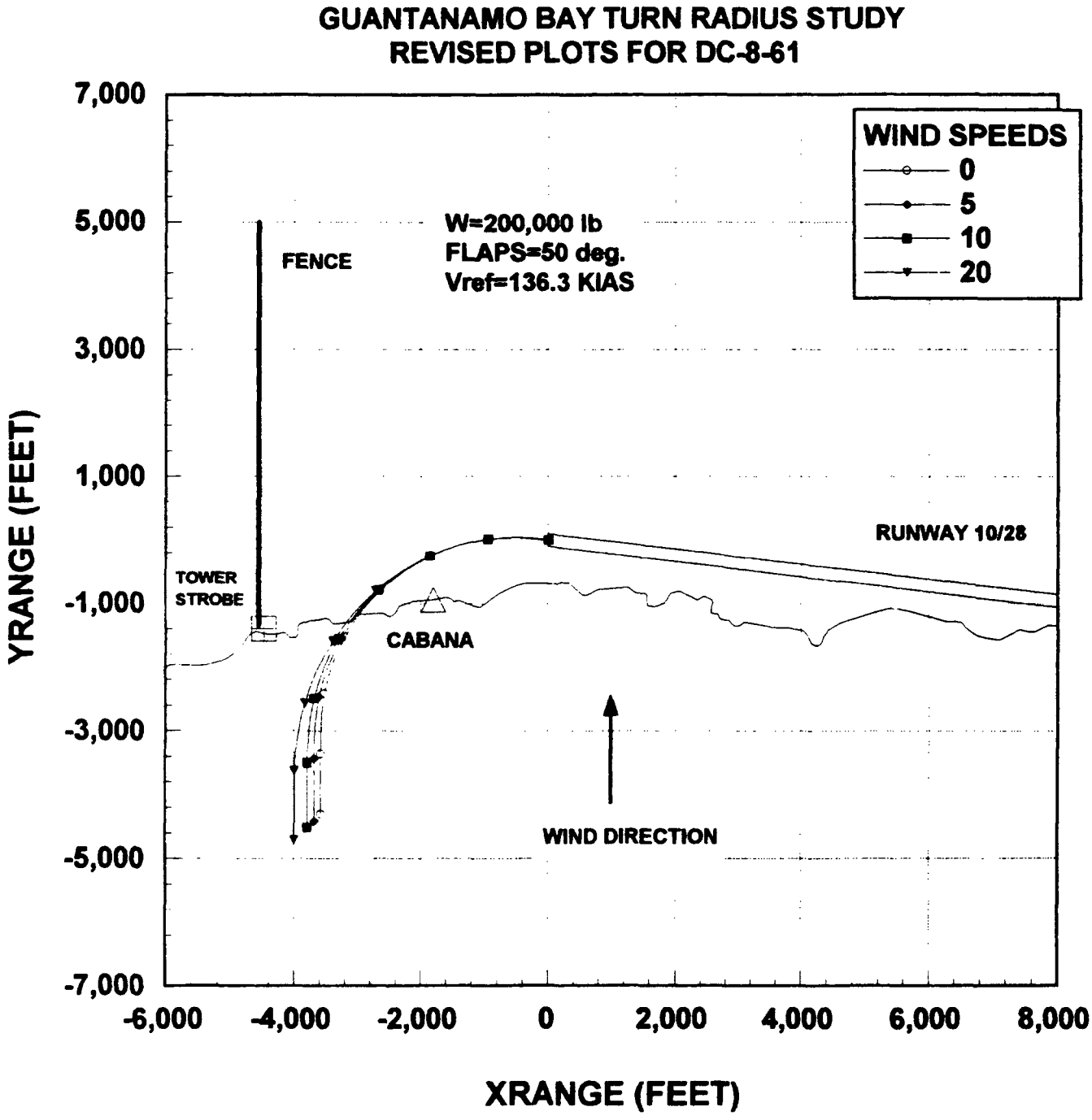
INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME & SOURCE	CONTENT	TIME & SOURCE	CONTENT
1654:06 **CAM-3**	{33:39} watch the, keep your airspeed up.		
1654:07 **CAM-2**	{33:40} one forty.		
1654:08 **CAM**	{33:40} ((sound similar to engine power being increased))		
1654:09 **CAM**	{33:42} ((sound similar to stall warning))		
1654:10 **CAM-?**	{33:43} (don't), stall warning.		
1654:11 **CAM-1**	{33:44} I got it.		
1654:12 **CAM-2**	{33:45} stall warning.		
1654:12 **CAM-3**	{33:45} stall warning.		
1654:13 **CAM-1**	{33:46} I got it. back off.		
1654:13 **CAM-?**	{33:46} max power. ((concurrent with previous statement))		
1654:15 **CAM-?**	{33:48} there it goes. there it goes.		

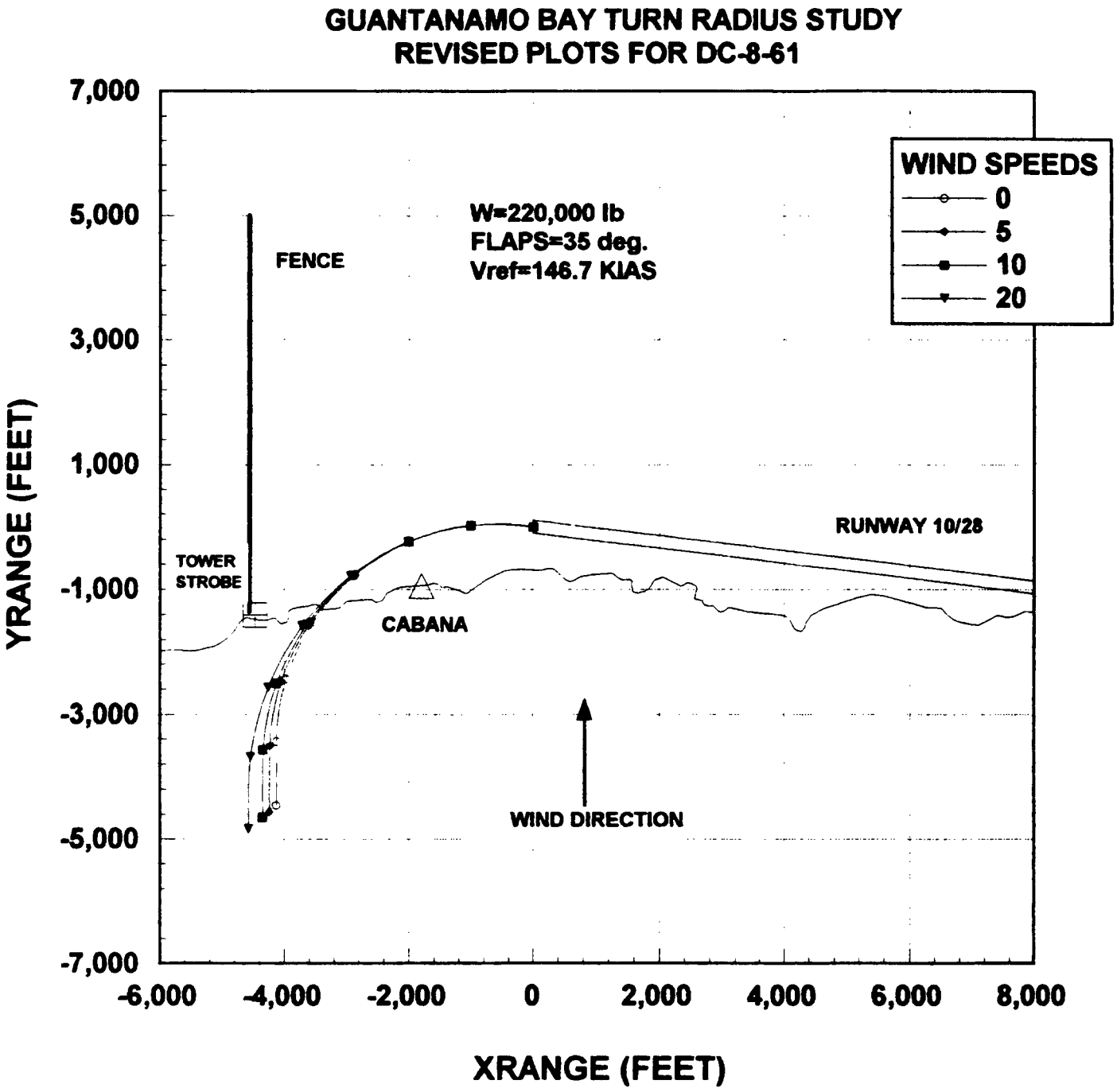
INTRA-COCKPIT COMMUNICATION		AIR-GROUND COMMUNICATION	
TIME & SOURCE	CONTENT	TIME & SOURCE	CONTENT
1654:16 {33:49} CAM-?	oh no.		
1654:17 {33:50} CAM	((sounds of several screams))		
1654:20 {33:53} END of RECORDING			
END of TRANSCRIPT			

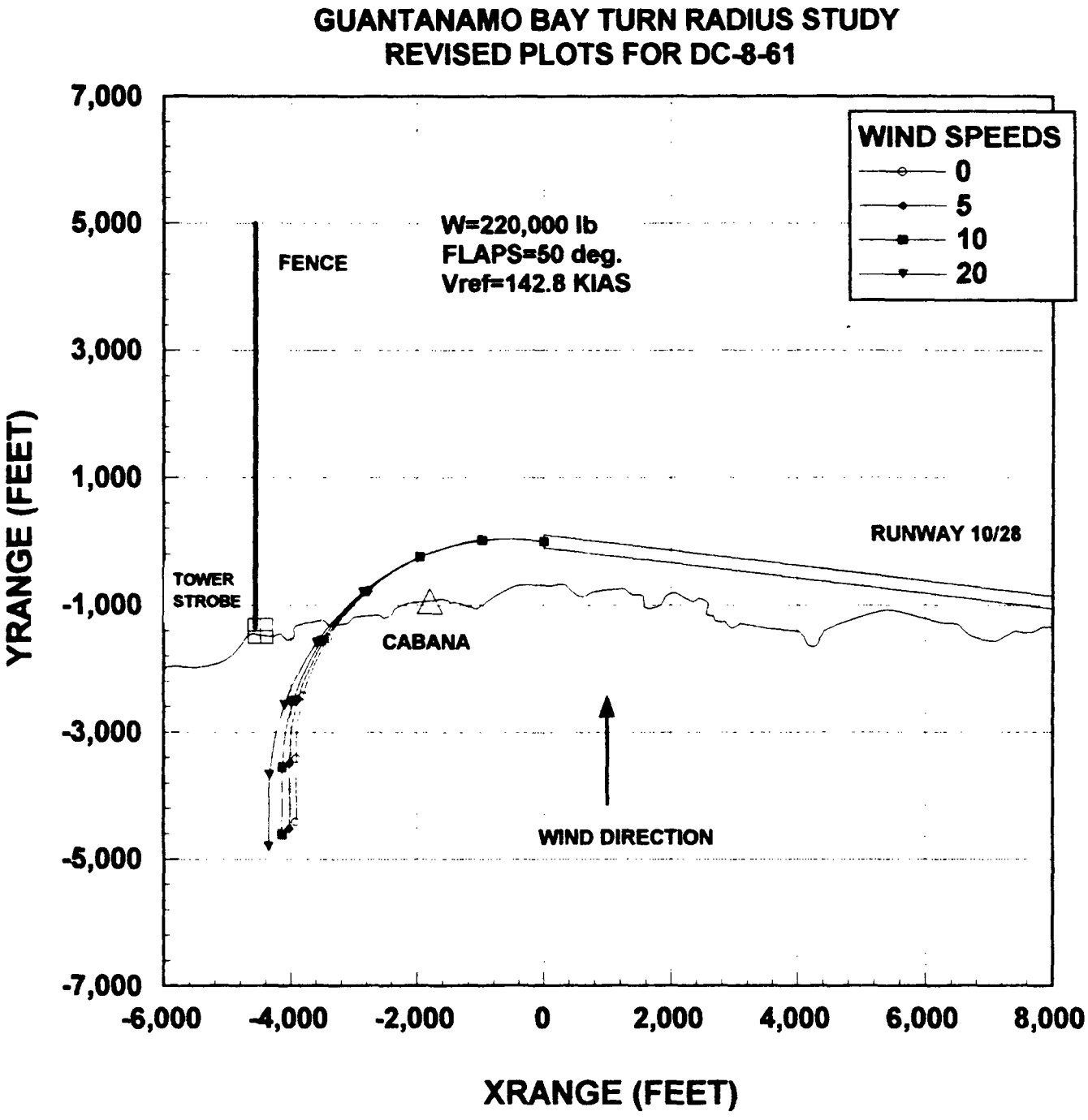
APPENDIX C

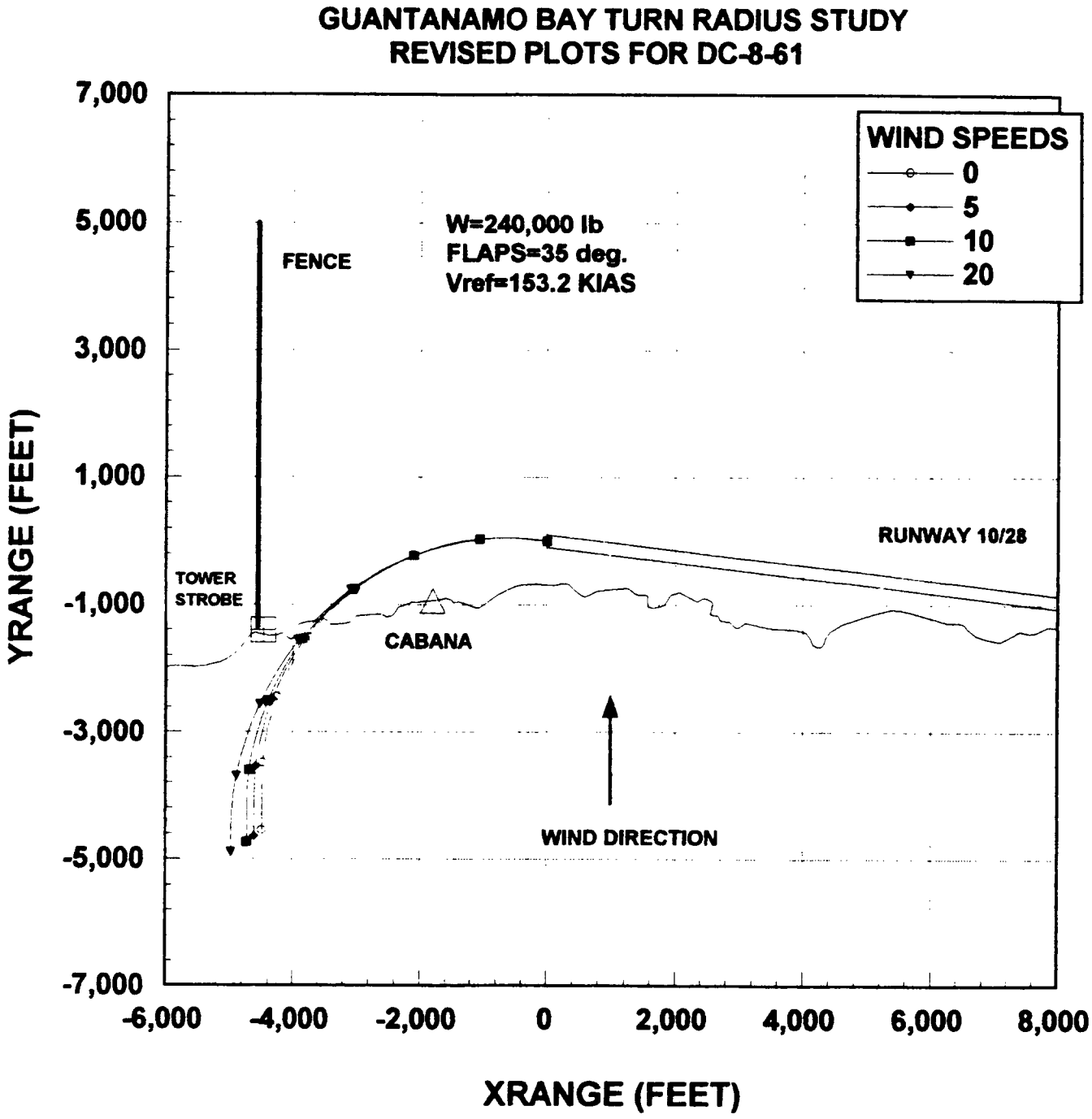
AIRPLANE PERFORMANCE INFORMATION




GUANTANAMO BAY TURN RADIUS STUDY
REVISED PLOTS FOR DC-8-61
WIND SPEEDS
0
5
10
20
W=200,000 lb
FLAPS=50 deg.
Vref=136.3 KIAS
FENCE
TOWER
STROBE
CABANA
RUNWAY 10/28
WIND DIRECTION
YRANGE (FEET)
XRANGE (FEET)
7,000
5,000
3,000
1,000
-1,000
-3,000
-5,000
-7,000
-6,000
-4,000
-2,000
0
2,000
4,000
6,000
8,000


GUANTANAMO BAY TURN RADIUS STUDY
REVISED PLOTS FOR DC-8-61
W=220,000 lb
FLAPS=35 deg.
Vref=146.7 KIAS
WIND SPEEDS
0
5
10
20
FENCE
TOWER
STROBE
CABANA
RUNWAY 10/28
WIND DIRECTION
YRANGE (FEET)
XRANGE (FEET)
7,000
5,000
3,000
1,000
-1,000
-3,000
-5,000
-7,000
-6,000
-4,000
-2,000
0
2,000
4,000
6,000
8,000


GUANTANAMO BAY TURN RADIUS STUDY
REVISED PLOTS FOR DC-8-61
WIND SPEEDS
0
5
10
20
W=220,000 lb
FLAPS=50 deg.
Vref=142.8 KIAS
FENCE
TOWER
STROBE
CABANA
RUNWAY 10/28
WIND DIRECTION
YRANGE (FEET)
XRANGE (FEET)
7,000
5,000
3,000
1,000
-1,000
-3,000
-5,000
-7,000
-6,000
-4,000
-2,000
0
2,000
4,000
6,000
8,000


GUANTANAMO BAY TURN RADIUS STUDY
REVISED PLOTS FOR DC-8-61
WIND SPEEDS
0
5
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W=240,000 lb
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STROBE
CABANA
RUNWAY 10/28
WIND DIRECTION
YRANGE (FEET)
XRANGE (FEET)
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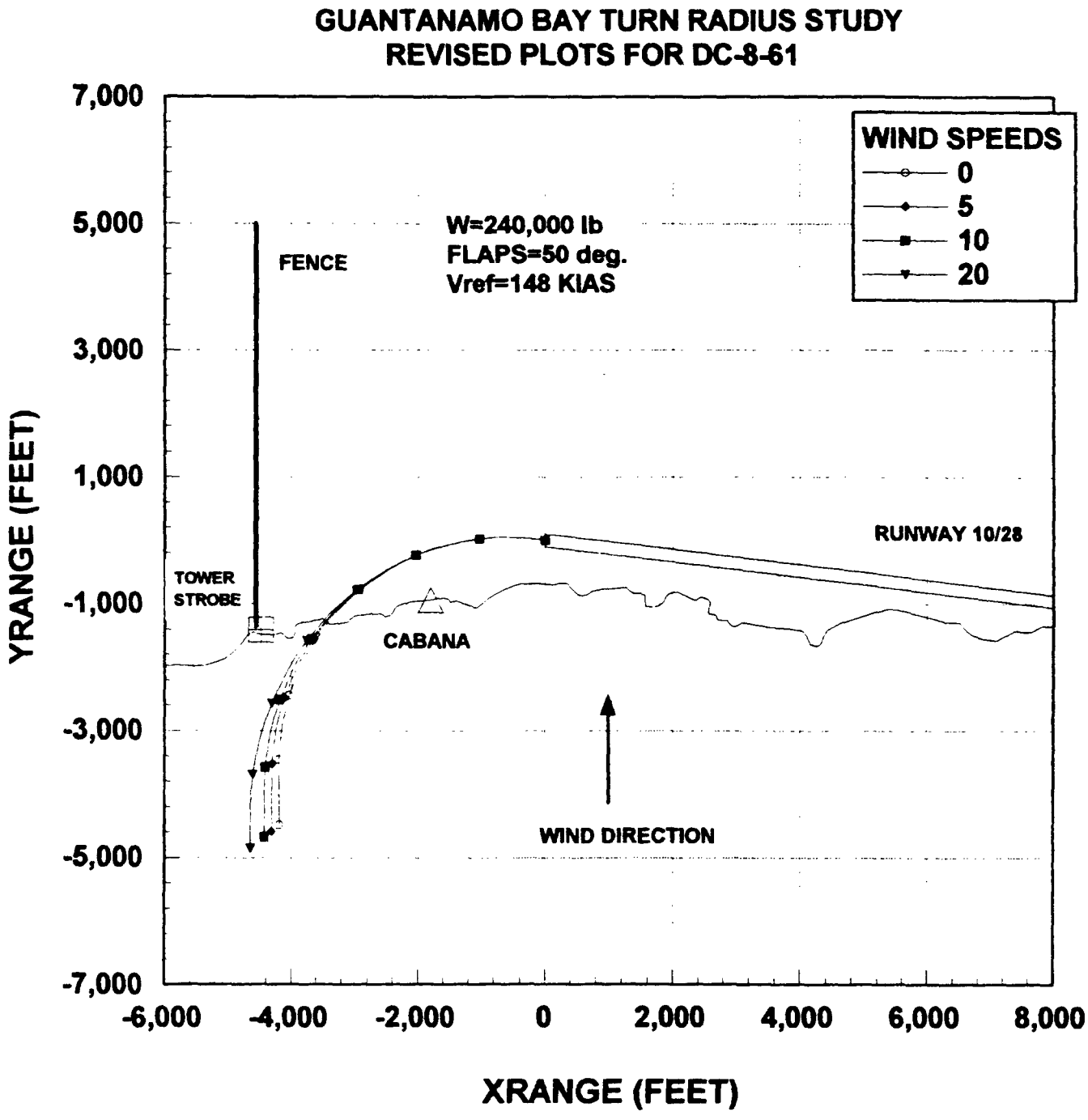
GUANTANAMO BAY TURN RADIUS STUDY
REVISED PLOTS FOR DC-8-61
WIND SPEEDS
0
5
10
20
W=240,000 lb
FLAPS=50 deg.
Vref=148 KIAS
FENCE
TOWER
STROBE
CABANA
RUNWAY 10/28
WIND DIRECTION
YRANGE (FEET)
XRANGE (FEET)
7,000
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APPENDIX D

FAA MEMORANDUM ON AIA OVERSIGHT

SUBJECT: American International Airways Surveillance — 8/2/93

From: CKSA Principal Inspectors

To: Assistant Manager, DTW-FSDO

In May of this year American International Airways (CKSA) began passenger operations with Boeing B747 aircraft, their principal area of operations being the Middle East. In July of this year CKSA completed negotiations with the Department of Defense to lease facilities at the former Wurtsmith AFB located in Oscoda, Michigan. Their primary goal is to establish an airline subbase at that location to perform major aircraft alterations and inspections. Currently two aircraft are undergoing cargo door installations at the facility. In addition CKSA continues to operate a "pseudo" subbase at Miami International Airport to support their South American airline operations.

In the past six months we have tried to perform the necessary surveillance functions that the above operations require with little success. Paramount to this lack of success is the lack of budget to adequately perform our tasks. Requests to the various geographic entities has resulted in limited feedback (one trip to Oscoda by GRR FSDO for a total of 4 hours of surveillance and several ramp checks at MIA by MIA FSDO).

As the CKSA geographical sphere expands so do their problems, and our limited surveillance consistently reveals the same negative trends. For this reason we have grave concerns regarding the quality of CKSA operations at these "remote" locations in the past and in the future.

Please consider this notice that we can no longer accept full responsibility for CKSA Certificate Management, particularly those portions requiring extended travel. With your assistance we are willing to attempt Certificate Management, however our employer must accept responsibility for the limitations imposed upon us.

The thrust of this memo is intended to be positive in that we are informing you of our problems and concerns.

Randal H. Drew — Marcel I. Loosbrock — David K. Johns

cc: L. McCartney
J. Stanley
R. Jakeway

APPENDIX E

ANALYSIS OF CREW FATIGUE FACTORS

Analysis of Crew Fatigue Factors in AIA Guantanamo Bay Aviation Accident

Mark R. Rosekind, Kevin B. Gregory[1], Donna L. Miller[1], Elizabeth L. Co[2], and J. Victor Lebacqz

Fatigue Countermeasures Program
Flight Human Factors Branch
NASA Ames Research Center

Introduction

Flight operations can engender sleep loss and circadian disruption that can affect flight crew performance, vigilance, and mood. Scientific information on sleep and circadian rhythms acquired over the past 40 years has clearly established human requirements for sleep and the detrimental effects of sleep loss and circadian disruption. The application of this scientific information to the 24-hour requirements of flight operations has been underway for over 12 years. A variety of sources clearly indicates that fatigue, as a result of sleep loss and circadian disruption, is an aviation safety issue that warrants attention.

The NASA Aviation Safety Reporting System (ASRS) is a confidential reporting system for flight crews and others to report difficulties and incidents in the National Airspace System. Approximately 21% of the incidents reported to ASRS are fatigue-related (ref. 1). Since its inception, ASRS has accumulated over 261,000 incident reports with about 52,000 of these reporting a fatigue-related occurrence. Since 1980, the NASA Ames Fatigue Countermeasures Program has examined the extent and effects of fatigue, sleep loss, and circadian disruption in a variety of flight environments (refs. 2, 3). This Program has collected anecdotal, subjective, physiological, and performance data documenting fatigue issues in flight operations (e.g., see refs. 4-8). The FAA has identified fatigue research as an important aviation safety issue in its National Plan for Aviation Human Factors. The National Transportation Safety Board (NTSB) has, on several occasions, called for specific actions regarding fatigue, including coordination of federal research activities, review and revision of hours of service regulations, and the dissemination of educational materials. Scientific data has clearly indicated that fatigue can be a factor in 24-hour operational environments, including aviation. This has been recognized at the Federal level by the FAA, the NTSB, other Federal agencies (e.g., Office of Technology Assessment, Federal Highway Administration), and ongoing NASA activities.

Basic Human Physiology: Sleep and Circadian Rhythms

The era of modern sleep research began in the mid-1950's with the discovery of two distinct states of sleep (ref. 9). Over the past 40 years, there has been extensive scientific research on sleep, sleepiness, circadian rhythms, sleep disorders, dreams, and the effects of these factors on waking alertness and human performance (e.g., see refs. 10, 11). Some of this basic information regarding human sleep, sleepiness, and circadian rhythms is presented as a foundation for examining the specifics of the AIA aviation accident at Guantanamo Bay.

1. Sleep is a vital human physiological function.

Historically, sleep has been viewed as a state when the human organism is turned off. Scientific findings have clearly established that sleep is a complex, active physiological state that is

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[1]Sterling Software, Inc.
[2]San Jose State University Foundation

vital to human survival. Like human requirements for food and water, sleep is a vital physiological need. When an individual is deprived of food and water, the brain provides specific signals—hunger and thirst—to drive the individual to meet these basic physiological needs. Similarly, when deprived of sleep, the physiological response is sleepiness. Sleepiness is the brain's signal to prompt an individual to obtain sleep. Sleepiness is a signal that a specific physiological requirement has not been met. Eventually, when deprived of sleep (acutely or chronically), the human brain can spontaneously, in an uncontrolled fashion, shift from wakefulness to sleep in order to meet its physiological need for sleep. The sleepier the person, the more rapid and frequent are these intrusions of sleep into wakefulness. These spontaneous sleep episodes can be very short (i.e., microsleeps lasting only seconds) or extended (i.e., lasting minutes). At the onset of sleep, an individual disengages perceptually from the external environment, essentially ceasing to integrate outside information. In a sleepy person, performance can begin to slow even before actual sleep intrusions into waking. A microsleep can be associated with a significant performance lapse when an individual does not receive or respond to external information. With sleep loss, these uncontrolled sleep episodes can occur while standing, operating machinery, and even in situations that would put an individual at risk, such as driving a car (refs. 12-14).

How much sleep does an individual need? Basically, an individual requires the amount of sleep necessary to achieve full alertness and their highest level of functioning during their waking hours. There is a range of individual sleep needs and, though most adults will require about 8 hours of sleep, some people need 6 hours while others require 10 hours to feel wide awake and function at their peak level during wakefulness.

2. Sleepiness affects waking performance, vigilance, and mood.

Sleep loss creates sleepiness and often this sleepiness is dismissed as a minimal nuisance or easily overcome. However, sleepiness can potentially degrade most aspects of human capability. Controlled laboratory experiments have demonstrated decrements in most components of human performance, vigilance, and mood as a result of sleep loss. Sleepiness can be associated with decrements in decision-making, vigilance, reaction time, memory, psychomotor coordination, and information processing (e.g., fixation on certain material to the neglect of other information). Research has demonstrated that with increasing sleepiness, individuals demonstrate poorer performance despite increased effort, and may report indifference regarding the outcome of their performance. Individuals report fewer positive emotions, more negative emotions, and an overall worsened mood with sleep loss and sleepiness (for scientific reviews of this area, see ref. 15-18).

Generally, sleepiness can degrade most aspects of human waking performance, vigilance, and mood. In the most severe instances, an individual may experience an uncontrolled sleep episode and obviously be unable to perform. However, in many other situations, while the individual may not actually fall asleep, the level of sleepiness can still significantly degrade human performance. For example, the individual may react slowly to information, may incorrectly process the importance of the information, may find decision making difficult, may make poor decisions, may have to check and recheck information or activities because of memory difficulties. This performance degradation can be a direct result of sleep loss and the associated sleepiness and can play an insidious role in the occurrence of an operational incident or accident (ref. 19-21).

3. Sleep loss accumulates into a sleep debt.

An individual who requires 8 hours of sleep and obtains only 6 hours is essentially sleep deprived by 2 hours. If the individual sleeps only 6 hours over 4 nights, then the 2 hours of sleep loss per night would accumulate into an 8-hour sleep debt. Estimates suggest that in the United States today, most adults obtain 1 to 1.5 hours less sleep per night than they actually need (ref. 22). During a regular work week this would translate into the accumulation of a 5 to 7.5-hour sleep debt going into the weekend; hence, the common phenomenon of sleeping late on weekends to compensate for the sleep debt accumulated during the week. Generally, recuperation from a sleep debt involves obtaining deeper sleep over 2 to 3 nights. Obtaining deeper sleep appears to be a physio-

logical priority over a significant increase in the total hours of sleep (i.e., sleeping 7.5 hours longer on the weekend to "make-up" for the sleep debt accumulated during the week).

4. Physiological vs. Subjective Sleepiness

Sleepiness can be differentiated into two distinct components: physiological and subjective. Physiological sleepiness is the result of sleep loss: lose sleep, get sleepy. An accumulated sleep debt will be accompanied by physiological sleepiness that will drive an individual to sleep in order to meet the individual's physiological need. Subjective sleepiness is an individual's introspective self-report regarding the individual's level of sleepiness (refs. 12, 23). An individual's subjective report of sleepiness can be affected by many factors. For example, caffeine, physical activity, and a particularly stimulating environment (e.g., an interesting conversation) can all affect an individual's subjective rating of sleepiness. However, an individual will typically report being more alert because of these factors. These factors can affect the subjective report of sleepiness and mask or conceal an individual's level of physiological sleepiness. Therefore, the tendency will be for individuals to subjectively rate themselves as more alert than they may be physiologically. This discrepancy between subjective sleepiness and physiological sleepiness can be operationally significant. An individual might report a low level of sleepiness (i.e., that they are alert) but be carrying an accumulated sleep debt with a high level of physiological sleepiness. This individual, in an environment stripped of factors that conceal the underlying physiological sleepiness, would be susceptible to the occurrence of spontaneous, uncontrolled sleep and the performance decrements associated with sleep loss (refs. 24-26).

5. The Circadian Clock.

Humans, like other living organisms, have a circadian (circa=around, dia=a day) clock in the brain that regulates physiological and behavioral functions on a 24-hour basis. In a 24-hour period this clock will regulate our sleep/wake pattern, body temperature, hormones, performance, mood, digestion, and many other human functions. For example, on a regular 24-hour schedule we are programmed for periods of wakefulness and sleep, high and low body temperature, high and low digestive activity, increased and decreased performance capability, etc. An individual's circadian clock might be programmed to sleep at midnight, awaken at 8 AM, and maintain wakefulness during the day (with an afternoon sleepiness period), and then the 24-hour pattern repeats itself. The circadian rhythm of body temperature is programmed for the lowest temperature between 3 and 5 AM on a daily basis (ref. 27).

When the circadian clock is moved to a new work/rest (or sleep/wake) schedule or put in a new environmental time zone, it does not adjust immediately. This is the basis for the circadian disruption associated with jet lag. Once the circadian clock is moved to a new schedule or time zone, it can begin to adjust and may take from several days up to several weeks to physiologically adapt to the new environmental time. Also, the body's internal physiological rhythms do not all adjust at the same rate and therefore, may be out of synch with each other for an extended period of time. Again, it can take from days to weeks for all of the internal rhythms to come together in a synchronous 24-hour rhythm on the new schedule or time zone. There are some specific factors that can affect the circadian clock's adaptation. Day/night reversal can confuse the clock so that the cues that help it adjust and maintain its usual physiological pattern are disrupted. Moving from a day to night schedule and back to days can keep the clock in a continuous state of readjustment, depending on the time between schedule changes. For example, severe effects would accompany a 12-hour day to night to day schedule alteration. Another factor is crossing multiple time zones. While there is some flexibility for adjustment, putting the circadian clock in a time zone three or more hours off home time will require a reasonable amount of physiological adaptation. Another factor can be the direction the clock is moved. Shortening the period (e.g., moving to a 21-hour cycle or day) is generally more difficult to achieve than is lengthening the period (e.g., moving to 25 or longer hours), which is the natural rhythm of the circadian clock. Therefore, it can be more difficult to cross time zones in an eastward direction compared to westward movement. It can also be more difficult to move a work/rest schedule backwards over the 24-hour day compared to

moving it forward (e.g., forward from day to swing to night shift). All of the associated difficulties of moving the clock, such as poor sleep, sleepiness, effects on performance, etc., will be affected until the circadian clock physiologically adapts to the new schedule or time zone (refs. 28, 29).

Scientific studies have revealed that there are two periods of maximal sleepiness during a usual 24-hour day. One occurs at night roughly between 3 and 5 AM, and the other in midday roughly between 3 and 5 PM. However, performance and alertness can be affected throughout a 12 AM to 8 AM window. Individuals on a regular day/night schedule will typically sleep through the 3-5 AM window of sleepiness. The afternoon sleepiness period can be masked by factors described previously, or present a window when individuals are particularly vulnerable to the effects of sleepiness. This also means that individuals working through the night are maintaining wakefulness from 3-5 AM when their circadian clock is programmed for sleep. Conversely, individuals sleeping during the day are attempting to sleep when the circadian clock is programmed for wakefulness. However, individuals searching for specific windows when they are physiologically prepared to sleep, either for an extended sleep period or a strategic nap, can use these periods to their advantage (ref. 12).

Specific Fatigue Factors to Examine in Investigations

Based on the previous scientific information regarding sleep and circadian rhythms, there are at least three core physiological factors to examine when investigating the role of fatigue in an incident or accident. The first is cumulative sleep loss. An individual's usual sleep amount is established based on their reported total sleep time at home. Using this figure as an individual's baseline sleep need, the amount of actual sleep obtained over a period of time can be used to calculate the cumulative sleep loss (i.e., sleep debt) or potentially, the sleep gained. Unless physiological or behavioral data is available, the reported amounts of sleep usually rely on subjective estimates of total sleep time. It is important to note that there is often a discrepancy between subjective sleep estimates and physiologically the amount of sleep obtained. Therefore, an important caveat is the self-report nature of the data, often obtained (i.e., recreated) after an incident or accident. The second factor is the continuous hours of wakefulness prior to the incident or accident. A general sleep/wake pattern will have an individual awake for about 16 hours and sleep for about 8 hours. However, operational requirements can involve extended duty periods that require continuous hours of wakefulness beyond this usual pattern. The third factor is time of day. This involves the time of operations and the time at which the incident or accident occurred. The time of day can also be a factor when examining when sleep periods occurred and the potential disruption of a usual circadian pattern.

The relationship of these factors can be especially informative. For example, an individual requiring 8 hours of sleep, who obtains 8 hours and is then awake for 20 hours will show less performance decrement than the same individual with 6 hours of sleep awake for 20 hours. With 8 hours of sleep, the individual is better prepared for the longer-than-usual period of continuous wakefulness than they would be with the combination of a sleep debt and the extended wake period. All three factors can come together to create the highest vulnerability for a performance decrement. The greatest decrement would be expected when an individual carrying a substantial sleep debt is required to operate for an extended period of continuous wakefulness, and the time of the operation passes through a period of increased sleepiness. Time of day could also affect the cumulative sleep loss if sleep periods were scheduled at less than optimal circadian times.

Analysis of Sleep/Wake Histories for AIA Flight Crew

The three factors described above were analyzed for the AIA Flight Crew involved in the Guantanamo Bay aviation accident. The data analyzed were taken from the NTSB Human Performance Investigator's Factual Report, the Operations Group Chairman's Factual Report, and the Flight 808 Crew Statements. When there were discrepancies among the sources, conservative

estimates and averages were used. The sleep/wake histories for the Flight Crew of AIA Flight 808 prior to the accident at Guantanamo Bay on August 18, 1993 at about 1656 EDT are presented in Figure 1. This figure provides an opportunity to examine the temporal organization and amount of sleep and wakefulness over the three days leading up to the accident. The days 8/16/93, 8/17/93, and 8/18/93 are identified at the top of the figure along with a 24-hour clock. The white bars indicate the duty periods and individual black lines show specific takeoff and landing activities during the duty periods. A single horizontal bar for each flight crewmember shows the sleep (black) and wakefulness (shaded) over the period leading up to the accident at about 1656 on 8/18/93.

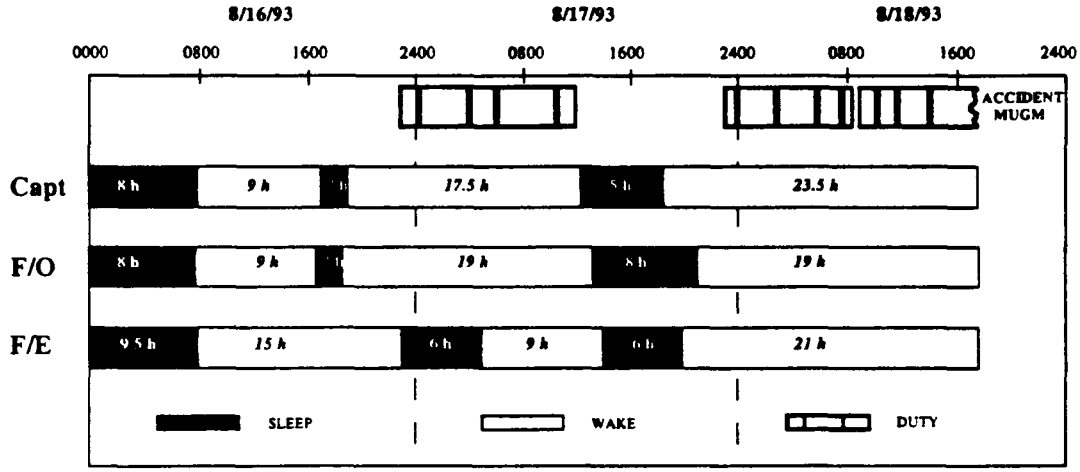

Figure 1. AIA Flight 808 Crew Sleep/Wake Histories

The first horizontal bar in Figure 1 displays the sleep/wake history of the Captain. He reported a typical sleep requirement of 8 hours. The Captain awakened on 8/16/93 after 8 hours of sleep and was awake for 9 hours before taking a 2-hour nap prior to his all-night duty period. Following his nap, the Captain was awake for 17.5 hours. He reported a 5-hour sleep period during a daytime sleep opportunity in a Dallas-Ft. Worth Airport hotel during layover. The Captain was then awake for 23.5 hours until the accident occurred at Guantanamo Bay. This 23.5 hour period included an all-night duty period after which the Captain was released from duty. However, he was called back to operate Flight 808 prior to his return home, and therefore was continuously awake until the accident.

The second bar in Figure 1 displays the sleep/wake history of the First Officer. He also reported a usual sleep requirement of 8 hours. The First Officer awakened on 8/16/93 after 8 hours of sleep and was awake for 9 hours before taking a 2-hour nap prior to his all-night duty period. Following his nap, the First Officer was awake for 19 hours. He reported an 8-hour sleep period during a daytime sleep opportunity in a Dallas-Ft. Worth Airport hotel during layover. The First Officer was then awake for 19 hours until the accident occurred at Guantanamo Bay. This 19-hour period included an all-night duty period after which the First Officer was released from duty. However, he was called back to operate Flight 808 prior to his leaving the airport, and therefore was continuously awake until the accident.

The third bar in Figure 1 displays the sleep/wake history of the Second Officer. He reported a usual sleep requirement of 9.5 hours. The Second Officer awakened on 8/16/93 after 9.5 hours of sleep and was awake for a usual 15-hour day before going to sleep at 2300 for a usual night of sleep. The Second Officer was then called at home after 6 hours of sleep and reported for duty at the airport, joining the Captain and First Officer. The Second Officer was then awake for 9 hours. He reported a 6-hour sleep period during a daytime sleep opportunity in a Dallas-Ft. Worth Airport

hotel during layover. The Second Officer was then awake for 21 hours until the accident occurred at Guantanamo Bay.

An examination of the cumulative totals for sleep and continuous wakefulness is informative. For the entire 65-hour period portrayed in Figure 1, which includes the last full 8-hour sleep period at home, the Captain was awake for 50 hours with 15 hours of sleep. Including the 2-hour nap, in the last 48 hours, the Captain was awake for 41 hours with 7 hours of sleep. For the 46 hours after the nap, the Captain was awake for 41 hours with 5 hours of sleep. In the last 28.5 hours prior to the accident, the Captain was awake for 23.5 hours with 5 hours of sleep.

For the entire 65-hour period portrayed in Figure 1, which includes the last full 8-hour sleep period at home, the First Officer was awake for 47 hours with 18 hours of sleep. Including the 2-hour nap, in the last 48 hours, the First Officer was awake for 38 hours with 10 hours of sleep. For the 46 hours after the nap, the First Officer was awake for 38 hours with 8 hours of sleep. In the last 27 hours prior to the accident, the First Officer was awake for 19 hours with 8 hours of sleep.

For the entire 66.5-hour period portrayed in Figure 1, which includes the last full 9.5-hour sleep period at home, the Second Officer was awake for 45 hours with 21.5 hours of sleep. In the last 42 hours, the Second Officer was awake for 30 hours with 12 hours of sleep. In the last 27 hours prior to the accident, the First Officer was awake for 21 hours with 6 hours of sleep.

Overall, this information demonstrates that the entire crew displayed cumulative sleep loss and extended periods of continuous wakefulness. It should be noted that the cumulative sleep loss can be partially attributed to the reversal of the circadian pattern, with nighttime sleep periods at home followed by daytime sleep periods due to all-night duty periods. Sleep obtained in opposition to the body's circadian rhythms is more disturbed than sleep that coincides with times when the body is programmed for sleep. The time of day factor also played a role. Also, the accident occurred at about 4:56 PM in the 3-5 PM window of sleepiness.

In a typical 24-hour period, most individuals would be awake about 16 hours and sleep about 8 hours. This represents a 2:1 wake/sleep ratio. Based on this general pattern, a calculation of the cumulative sleep/wake debt is portrayed in Figure 2. The wake/sleep ratio is displayed along the left axis. A ratio of 2:1 or 2 represents a usual baseline pattern (shown by the solid line) with a wake/sleep ratio less than 2 representing a sleep gain. A wake/sleep ratio greater than 2:1 or 2 would represent a sleep loss. The three days prior to the trip are portrayed on the horizontal axis.

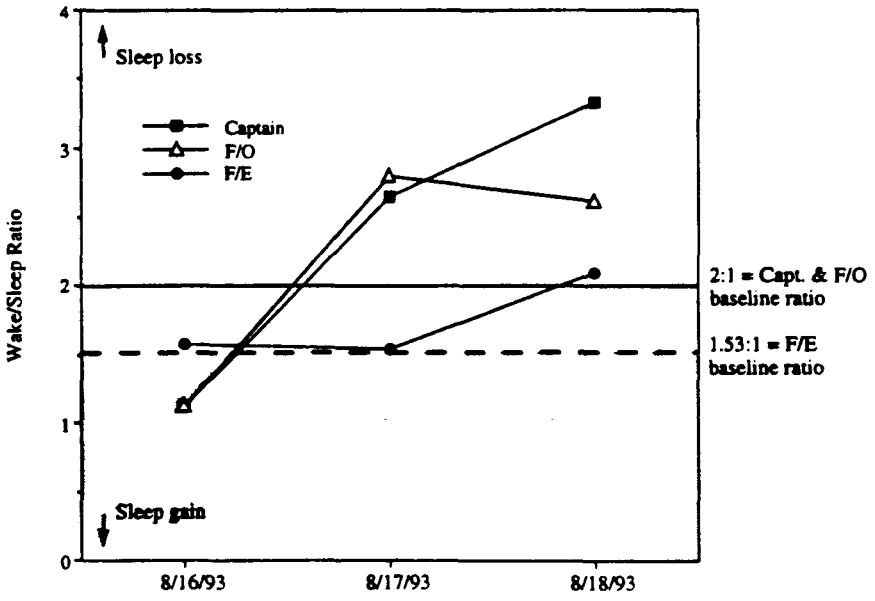

Figure 2. Cumulative Sleep/Wake Debt

The Captain and First Officer reported a usual sleep requirement of 8 hours and therefore, a wake/sleep ratio of 2 would be their appropriate self-defined norm. As evidenced in Figure 2, the wake/sleep ratio for both the Captain and First Officer is greater than 2 (indicated by the solid line) over the two days prior to the accident, reaching greater than 3 for the Captain. The Second Officer reported a usual sleep requirement of 9.5 hours. This represents a wake/sleep ratio of 1.53 as his self-defined norm (indicated by the dashed line). He approximates this on 8/16 and 8/17 and exceeds a ratio of 2 prior to the accident.

Taken together these data demonstrate that the entire flight crew displayed cumulative sleep loss, operated during an extended period of continuous wakefulness, and obtained sleep at times in opposition to the circadian clock time for sleep, and that the accident occurred in the afternoon window of physiological sleepiness. In consideration of the previous scientific information and the specific factors examined in this accident, the data clearly support the finding that fatigue was a physiological factor for the entire crew.

Evidence that Fatigue Factors Affected Performance

The data presented in the previous section demonstrated that the entire crew had experienced sleep loss, extended periods of continuous wakefulness, and circadian disruption (both the timing of sleep periods and time of accident). However, unlike alcohol, there is no chemical test for fatigue. Therefore, it is extremely difficult in an accident investigation, after the fact, to specifically demonstrate that fatigue was causal or contributory. However, as noted earlier, pilots cite fatigue as a common reason for incidents they report to ASRS. Over the past 10 years, the majority of aviation accidents were attributed to flight crew or human error. It is critical to more fully understand the specific sources of those errors if the current incident and accident rate is to be reduced further. Given the sleep/wake and circadian history of the entire flight crew, it is clear fatigue was present. However, to determine how fatigue may have contributed, one would have to determine from other sources whether performance and behavioral changes associated with fatigue were evident before the accident.

Two sources of data available for examination provide specific information regarding flight crew performance and behavior before the accident. The transcript of the cockpit voice recorder (CVR) was made available at the NTSB hearing on this accident, and the Captain provided testimony at the hearing.

1. Information from the CVR prior to the accident.

The CVR transcript provides information about flight crew performance, decisions, and responses leading up to the accident at Guantanamo Bay. There are four specific pieces of information that are relevant to the analysis of fatigue factors. The first piece of information is the decision to use runway 10. Two of the crewmembers, including the Captain (the pilot flying), had never flown into Guantanamo Bay; the First Officer had only flown into Guantanamo Bay years before in small military jets. The crew acknowledged that it was a difficult airport with special considerations. The plan had been to use the straightforward approach available on runway 28. With essentially no discussion, the Captain decided to change plans and use runway 10, which requires a more severe maneuver to complete the landing. By all reports, the Captain was lauded for his airmanship and good judgment, especially in emergency and landing procedures. Therefore, for an experienced Captain to make a sudden decision to change runways, with no prior experience at a special airport and with minimal crew discussion, suggests a degraded decision-making process. Fatigue can affect an individual's decision-making. In this situation, fatigue may have affected the crew's decision-making in the following ways: a) they did not consider important information (i.e., their unfamiliarity with the airport, their level of fatigue), b) their lack of discussion about the decision to change runways, and c) misreading of potential outcomes. In this case, the decision-making process was shared by the entire flight crew, all of whom were affected by the fatigue factors outlined.

A second piece of information from the CVR was the Captain's fixation on the strobe light. In the transcript, the Captain makes seven (possibly eight) references to the strobe light. During the critical period leading up to the accident, the Captain displayed an overwhelming focus and concern to locate the strobe light. This fixation on the strobe light, to the exclusion of other critical information, could also be an expression of the effect of fatigue on performance. It would fit laboratory research that demonstrates that this effect can result from sleep loss (ref. 15-21).

A third piece of information from the CVR was the Captain's disregard of critical information just prior to the accident. While the Captain was fixated on locating the strobe light and was making multiple references to its location, another crewmember questioned whether they were going to make the landing. The Captain did not acknowledge the question, certainly did not process the potential implications of the question, and finally disregarded the critical information to continue his search for the strobe light.

A fourth piece of information from the CVR was the response to the stall warning when the operation was clearly in trouble. Several pilots reviewed the CVR transcript and spontaneously commented on how slowly the Captain and crew responded to the stall warning prior to the accident. The warning is intended to provide a window for immediate response and an opportunity to recover the aircraft. An experienced pilot will have been trained to immediately respond to the stall warning with an automatic response. However, fatigue can degrade reaction time and psychomotor responses. Therefore, the Captain and crew may have been slow to respond to the stall warning as a consequence of the prior sleep loss, circadian disruption, and extended period of continuous wakefulness.

There are also several other instances from the CVR that suggest elements of fatigue but are more subtle. For example, there appears to have been excessive checking of information (e.g., were waypoints entered, radio frequencies). These more subtle occurrences may also reflect decreased memory and mental functioning but are less clearly defined than the previous four examples from the CVR.

The level of performance demonstrated by the Captain is below that normally expected of a Captain with his level of experience. However, the Captain's aviation record does not suggest that he was a substandard pilot. The Captain's airmanship was lauded from several sources. Therefore, some factor must have interfered with his performance on this flight. Also note that the CVR performance decrements identified above were all CRM failures. This further supports the previously presented data that the entire crew, not just the Captain, were affected by fatigue.

The examples identified above were summary points available from an initial examination of the CVR transcript made available at the NTSB accident hearing. A more detailed analysis of the CVR transcript could provide more specific information and data regarding the expression of fatigue-related performance and behavioral changes before the accident.

2. Captain's testimony.

The other piece of information available at the NTSB hearing was the Captain's testimony. Perhaps the most telling statement was in response to the question about how he felt just prior to the accident and he said, "lethargic and indifferent." Individuals use a variety of words to express their state associated with sleep loss and circadian disruption, for example, 'fatigued,' 'tired,' 'sleepy,' and 'lethargic.' Also, as previously mentioned, controlled laboratory studies of sleep deprivation have shown that individuals will increase their effort to perform, though their performance is degraded, and they become indifferent to the outcome. The Captain's report of being "lethargic and indifferent" in the period leading up to the accident is quite consistent with the typical pattern of sleep and circadian disruption.

Conclusions

Over the past 40 years, there has been tremendous progress in our scientific understanding of sleep and circadian rhythms. Over the past 12 years, this information has been specifically applied to the operational requirements of the aviation industry. The human need for sleep and the effects of sleep loss and circadian disruption on waking performance are of particular importance in the current aviation accident investigation. The subjective sleep/wake data provided by flight crewmembers was analyzed for cumulative sleep loss, extended periods of continuous wakefulness, and time of day effects. The results demonstrated that these three fatigue factors affected all three flight crewmembers. Based on the known effects of fatigue, sleep loss, and circadian disruption on human performance, other sources of information were examined to determine whether fatigue-related performance decrements occurred prior to the accident. Four examples from the CVR transcript and the Captain's testimony provide information of specific performance and behavioral occurrences that fit the expected effects of fatigue on human functioning. The hypothesis that fatigue affected the crewmembers' performance is supported by the amount of cumulative sleep loss, continuous wakefulness, and circadian disruption experienced by the entire crew. The examples from the CVR and Captain's testimony support the hypothesis that fatigue had an effect on flight crew performance that was related to specific actions involved in the occurrence of the accident at Guantanamo Bay.

Two final notes. First, it is important to acknowledge the limitations of human physiology regarding sleep, circadian rhythms, and fatigue. The flight crewmembers involved in this accident were clearly professional, well-trained, experienced, and highly motivated to perform their best. As humans, there are limitations to our performance that are purely a reflection of our physiological capabilities and are independent of training, motivation, and experience. Second, there is no simple, easy "cure" to fatigue issues in aviation operations. Individuals are different, what they do is different, and the operational demands of the aviation industry are diverse. Therefore, no one approach or "solution" will address the fatigue engendered by some flight operations. An examination of every aspect of the aviation system, including regulatory, scheduling, personal strategies, and the design of technology, is critical in addressing fatigue in flight operations. The task is to apply our scientific understanding of human physiological needs for sleep and circadian rhythms to the 24-hour operational requirements of the aviation industry. Whenever possible, this information should be applied to maintain and improve the safety margin and promote maximal alertness and performance during operations.

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